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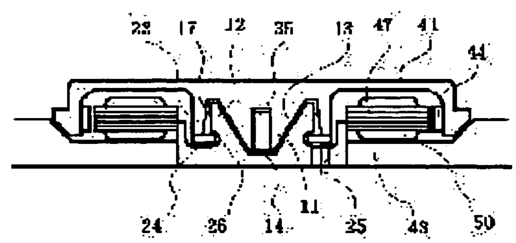
## (54) MOTOR EQUIPPED WITH SINGLE AND CONICAL DYNAMIC PRESSURE FLUID BEARING BALANCED WITH MAGNETIC ATTRACTION ON END OF SHAFT


(57)Abstract:

PROBLEM TO BE SOLVED: To realize and provide a motor equipped with a single and conical dynamic pressure gas bearing where such problems of the motor equipped with the single conical dynamic pressure gas bearing as stability of rotating posture, the realization of easily-assembling structure from which lubricant fluid is hard to leak or the like are solved, making a thinner shape and lower current to be applicable, so that simple structure and cost reduction are possible.

SOLUTION: This motor comprises a shaft having a tapered surface getting gradually thinner in diameter in an approximately conical-shaped manner, a sleeve having a concave portion opposed to the shaft, lubricant fluid within gap between the shaft and the sleeve, and a magnetic means having a magnet and a magnetic substance either within the shaft or on a bottom surface of the sleeve to generate magnetic attraction between a shaft end and the bottom surface of the sleeve. Further, the features of the motor are that dynamic pressure groove is provided on the shaft or on a conical-shaped and tapered surface of the sleeve and an axial component force of magnitude of a load generated by the above dynamic pressure groove in the case of rotation and the above magnetic attraction are made to be balanced to support a rotating portion. Thereby, there is realized the motor, equipped with the single and conical gas dynamic pressure bearing, where thinner shape, lower current and cost reduction are possible controlling NRRO.

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## CLAIMS

[Claim(s)]
[Claim 1] The shaft which has the taper side where a shaft diameter becomes thin gradually the shape of an approximate circle drill, and a sleeve with the cone-like crevice which counters a shaft, The magnetic means which it has [ magnetic means ] a magnet and the magnetic substance at either, respectively in the inside of a shaft, and the lubrication fluid of the gap between sleeves and a shaft, or the sleeve crowning, and generates the magnetic-attraction force between an axis end and a sleeve crowning, In the fluid hydrodynamic bearing motor which consists of annular obstructions which have the gap which is arranged at the axial periphery section, counters a sleeve peripheral wall, and serves as size gradually towards opening, and form the taper seal section The fluid hydrodynamic bearing motor characterized by having a dynamic pressure slot in the cone-like taper side of a shaft or a sleeve, equilibrating the shaft-orientations component of a force and said magnetic-attraction force of the load-carrying capacity which said dynamic pressure slot generates at the time of rotation, and supporting the rotation section [claim 2] In a fluid hydrodynamic bearing motor according to claim 1, constitute said magnetic means from a permanent magnet held movable in a shaft by adult holding power rather than said magnetic-attraction force, and the sleeve side magnetic substance, and it sets at said permanent magnet edge. It is the fluid hydrodynamic bearing motor [claim 3] characterized by size enabling justification and immobilization of said permanent magnet at the time of assembly so that it may not become from shaft-orientations surfacing distance [ in / a sleeve is contacted at the time of quiescence, and it estranges at the time of rotation, and / in the clearance / the conical surface of a shaft and a sleeve ]. After constituting said magnetic means from a permanent magnet held movable in a shaft by adult holding power rather than said magnetic-attraction force, and the sleeve side magnetic substance in a fluid hydrodynamic bearing motor according to claim 1 and making a permanent magnet fully project from an axis end, between a shaft and a sleeve the force beyond said magnetic-attraction force In addition, so that the location of a permanent magnet may be decided in the condition that the flat spring arranged at the sleeve crowning or the sleeve crowning produces elastic deformation The cone crowning or flat spring, and permanent magnet edge of an assembly and a sleeve are a fluid hydrodynamic bearing motor [claim 4] characterized by constituting size so that it may not become from shaft-orientations surfacing distance [ in / it contacts at the time of quiescence, it estranges at the time of rotation, and / in the clearance / the conical surface of a shaft and a sleeve ]. The fluid hydrodynamic-bearing motor characterize by to establish a spiral-like dynamic-pressure slot which carry out the pumping of the lubrication fluid towards the field which give the crown about several micron meter for any of the cone-like taper side of a shaft and a sleeve being so that it may become a least interval in a fluid hydrodynamic bearing motor according to claim 1 by the staging area of the shaft orientations which the cone-like taper side of a shaft and a sleeve counter, and serve as said least interval in the shaft-orientations both sides or one side of said least interval field [claim 5] The fluid hydrodynamic bearing motor characterized by preparing the shaft which serves as a least interval in a fluid hydrodynamic bearing motor according to claim 4 with the crown configuration prepared in the cone-like taper side of a shaft or a sleeve, and the slot of the cone-like taper side of a sleeve around gone to which field at least [claim 6] It is the fluid hydrodynamic bearing motor [claim 7] which has a dynamic pressure slot in a fluid hydrodynamic bearing motor according to claim 1 in the location which counters the shaft orientations of cone-like taper both sides of a shaft and a sleeve, and is characterized by hoop direction include-angle length differing, as for the dynamic pressure slot in each field. The fluid hydrodynamic bearing motor characterized by making the shaft-orientations movable distance of the rotation section restrict in a fluid hydrodynamic bearing motor according to claim 1 between the ring-like member fixed to said annular obstruction edge, and the annular crevice established in the sleeve peripheral wall corresponding to the ring-like member [claim 8] It is the fluid hydrodynamic bearing motor [claim 9] which presupposes that said ring-like member is fixed to said annular obstruction edge with means, such as HAME ****, adhesion, or welding, in a fluid hydrodynamic bearing motor according to claim 7, and is characterized by having an access hole required for immobilization in the fixed part

side which counters said annular obstruction edge, or rotation section flank material. Have a means to insert in an annular obstruction edge and each other's ring-like member, and to fix in a fluid hydrodynamic bearing motor according to claim 8, and an access hole is minded. The fluid hydrodynamic bearing motor characterized by dashing against the end face of said annular crevice where push elastic deformation of the inner circumference part of a ring-like member is carried out, inserting each other's ring-like member in an annular obstruction edge, fixing, and carrying out an adjustment setup of the shaft-orientations movement magnitude of moving part as said elastic deformation of a ring-like member [claim 10] The fluid hydrodynamic bearing motor characterized by making cellular exclusion in a lubrication fluid easy in a fluid hydrodynamic bearing motor given in claim 1 term, using magnetic fluid oil as a lubrication fluid [claim 11] The fluid hydrodynamic bearing motor characterized by mixing conductive magnetic-substance fines into a lubrication fluid, making a bridge construct between an axis end and a sleeve crowning in a fluid hydrodynamic bearing motor according to claim 1, and making it flow electrically

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[Translation done.]

* NOTICES *



## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially this invention relates to the fluid hydrodynamic bearing motor which has bearing of a cone configuration and enables thin-shape-izing and low cost-ization with respect to a fluid hydrodynamic bearing motor.
[0002]
[Description of the Prior Art] In the storage of a rotation mold, the fan for cooling, etc., it is in the adoption direction of a fluid hydrodynamic bearing motor from the request of NRRO (asynchronous shaft deflection) control of silence or body of revolution etc. Coincidence is called on for thin-shape-izing of these devices, low current-ization, etc. with progress of a portable way. However, a fluid hydrodynamic bearing has a limitation in thin shape-ization that it is hard to make small the span between the bearing sections which support a shaft from a viewpoint which oppresses NRRO, and needs the process tolerance below submicron one for bearing gap maintenance, and a difficult situation has low cost-ization.
[0003] Even if it eases the process tolerance of a member for low cost-ization further, it is realizing **, such as structure it being freed from the bearing supported by two points of shaft orientations to enable thin shape-ization in a fluid hydrodynamic bearing, structure which can decrease a bearing sliding aspect product for low current-ization, and structure a bearing gap's being maintainable in a required precision.
[0004] The fluid hydrodynamic bearing of the cone configuration which serves as this candidate could support the load of a radial and the thrust direction, and has attracted attention since before. However, the single cone structure of being suitable for thin shape-ization was not fully successful, although there was a proposal with the gas bearing structure like publication of unexamined utility model application Heisei 06-004731 etc. The main reason is in the ability to fully have not stopped NRRO at the time of rotation with single cone structure. Although concomitant use with a cone bearing and cylinder bearing is proposed by JP,2000-004557,A and JP,2000-205248,A for a property improvement, cylinder bearing has resulted in bearing gap maintenance taking precise processing to and killing the advantage of a special cone bearing. moreover, single cone structure -- although there is also an example of a gas bearing shown in USP05854524 using spherical-surface configuration dynamic pressure bearing single as similar, there is the need of adjusting the radius of the two spherical surfaces strictly for fully securing the load-carrying capacity of a radial direction, and low-cost-izing is easy and there is. [ no ]
[0005]
[Problem(s) to be Solved by the Invention] The technical problem in the fluid hydrodynamic bearing motor of a single cone configuration is the stability of a rotation posture, and a lubrication fluid cannot leak easily and it is implementation of the easy structure of assembly. The purpose of this invention is solving said technical problem, and it being suitable for thin-shape-izing and low current-ization, and making implementation offer of the fluid hydrodynamic bearing motor of the single cone configuration in which low-cost-izing is possible with simple structure.
[0006]
[Means for Solving the Problem] The shaft with which the fluid hydrodynamic bearing motor by this invention has the taper side where a shaft diameter becomes thin gradually the shape of an approximate circle drill, A sleeve with the crevice which counters a shaft, and a shaft and the lubrication fluid of the gap between sleeves, It is arranged at the magnetic means which generates the magnetic-attraction force between an axis end and a sleeve crowning, and the axial periphery section, and a sleeve peripheral wall is countered. In the fluid hydrodynamic bearing motor which consists of annular obstructions which have the gap which serves as size gradually towards opening, and constitute the taper seal section It is characterized by having a dynamic pressure slot in the cone-like taper side of a shaft or a sleeve, equilibrating the shaft-orientations component of a force and said magnetic-attraction force of the load-carrying capacity which said dynamic pressure slot

generates at the time of rotation, and supporting the rotation section. Seal structure of a stable lubrication fluid is realized as structure which arranges the interface of a lubrication fluid on a sleeve periphery also at the time of high-speed rotation.
[0007] A ring-like member is fixed to the annular obstruction edge of arrangement in the axial periphery section, the inner circumference section of the ring-like member is arranged so that it may become in the annular crevice of a sleeve peripheral wall, and the shaft-orientations movement magnitude of the rotation section is regulated. The rotation section at the time of being added escapes from an excessive impact, and it is stop structure.
[0008] The magnetic means which generates the magnetic-attraction force consists of the permanent magnets and the magnetic substance which have been arranged in the inside of a shaft, or the sleeve crowning which counters, respectively. The magnetic-attraction force of an axis end is combined with the load-carrying capacity which a dynamic pressure slot generates, forms posture stability, and can improve posture stability further.
[0009] In a shaft, the permanent magnet held movable by adult holding power from the magnetic-attraction force It has. The location of a permanent magnet is made to decide in the condition that the flat spring which applied the force beyond the magnetic-attraction force between the shaft and the sleeve, and has been arranged at the sleeve crowning or the sleeve crowning after making a permanent magnet fully project from an axis end at the time of assembly produces elastic deformation. shaft-orientations surfacing distance [ in / the cone crowning or flat spring, and permanent magnet edge of a sleeve contact at the time of quiescence, are estranged at the time of rotation, and / in the clearance / the conical surface of a shaft and a sleeve ] -- smallness -- or it constitutes so that it may become equal. Poor starting which the conical surface of a shaft fits into a sleeve and produces to it by this at the time of quiescence is eliminated, and dependability can be improved.
[0010] The structure of distributing the amount of delay until it allots the dynamic pressure slot where hoop direction include-angle length differs, respectively in the almost same shaft-orientations location of the shaft which furthermore counters, and sleeve cone-like both sides and becomes a maximum pressure power point from the least interval point of a hoop direction, and avoiding unstable phenomena, such as half HOWARU, is proposed.
[0011] Moreover, making conductive magnetic-substance fines mix into a lubrication fluid, making it restrain in the field between an axis end and a sleeve crowning, and constituting the electric earthing means of the rotation section has also proposed.
[Function] If it depends on the fluid hydrodynamic bearing motor by this invention, the load-carrying capacity generated by rotation will be perpendicular to a conical surface, and a shaft and a sleeve will be rotated by non-contact in the location where the shaft-orientations component of a force and magnetic-attraction force balance. The direction component of a force of a path of load-carrying capacity balances on each point of a hoop direction, respectively, and contributes to alignment of the rotation section. Since the load-carrying capacity itself is still more nearly perpendicular to a conic taper side, it becomes stability when a rotation posture inclines by using conic top-most vertices as the supporting point.
[0012] The magnetic-attraction force of an axis end is combined with the load-carrying capacity which a dynamic pressure slot generates, forms the moment force of posture restoration, and can improve posture stability further.
[0013] In the bearing of the conventional single cone structure, the big factor which did not succeed in posture maintenance of the rotation section is in the situation which was being made into the structure of using magnetic bearing together like publication of unexamined utility model application Heisei 06-004731, and adding the load below a self-weight to bearing, in order that only a self-weight may avoid the wear at the time of deactivation for the load added to bearing. Since the shaft-orientations component of a force and the load of load-carrying capacity of bearing balance and are stabilized as already explained, by the small load, the load-carrying capacity to generate is stopped small and sufficient posture stability to maintain a rotation posture to stability is not acquired. At the fluid hydrodynamic bearing by this invention, stabilization of a rotation posture was enabled by making the load which the magnetic-attraction force is made to act between a shaft and a sleeve, and is added to bearing into the value of a request of the magnitude of the load-carrying capacity of the bearing which makes size, and is opposed and generated. The magnitude of the magnetic-attraction force changes with conditions, such as extent of permissible NRRO, and magnitude of a motor.
[0014]
[Embodiment of the Invention] It explains below, referring to a drawing for the example, a principle operation, etc. about the fluid hydrodynamic bearing motor by this invention.
[0015] Before explaining the example of this invention, drawing 14 explains the conventional fluid hydrodynamic

bearing motor structure. The conventional fluid hydrodynamic bearing motor has two radial bearings constituted from a shaft 91 and a cylinder-like sleeve 92, and two thrust bearings constituted to thrust plate 93 both sides, and has the dynamic pressure slot of its its herringbone configuration. Between the shaft 91 and the sleeve 92, about 2 micron m and in the thrust-bearing section, it has an about [ 10 micron m ] gap between a thrust plate 93, and a sleeve 92 and a thrust bush 94 in a radius, and is filled with the radial bearing section by the lubrication fluid.

[0016] Existence of two radial bearings and a thrust plate 93 makes thin shape-ization of the whole motor difficult. Since the load-carrying capacity of the bearing section is dependent on the magnitude of a gap, it is important for it to manage severely the squareness of to realize these gaps with a sufficient precision in a mass-production phase, a shaft 91, a hub 95 and a shaft 91, and a thrust plate 93 etc., and it causes a cost rise. Moreover, although the joint of a thrust bush 94 and a sleeve 92 is a part which a lubrication fluid touches and adhesion, caulking, or laser welding is performing a seal and immobilization, the serious failure is often caused that it is easy to produce lubrication fluid leakage from a joint clearance. a number 96 -- the Rota magnet -- in 97, 98 shows a coil and 99 shows the base for a stator core, respectively.

[0017] Drawing 1 shows the cross-section structure of the fluid hydrodynamic bearing motor which is the example of this invention. A shaft 11 is made into the cone configuration to which the path is tapering off, and makes the sleeve 12 which counters a shaft 11 and is arranged a cone-like concave surface. The gap between a shaft 11 and a sleeve 12 is filled up with the magnetic fluid oil which is a lubrication fluid, and the gap of the annular obstruction 23 formed in the periphery section of a shaft 11 and the peripheral wall of a sleeve 12 forms the taper seal section in shaft orientations as a size gradually, and has the interface 17 of a lubrication fluid. A shaft 11 has a permanent magnet 35 in it, and generates the magnetic-attraction force between sleeve 12 crownings which consisted of the magnetic substance. Consisting of the rotation section from a shaft 11, an annular obstruction 23, a hub 41, and rotor magnet 44 grade, a fixed part consists of a sleeve 12, the base 43, a stator core 47, and coil 50 grade.

[0018] The dynamic pressure slot of a herringbone configuration explained later is ******(ed) in which cone-like taper side 13 of a shaft 11 and a sleeve 12, and the bearing section is formed in it. The dynamic pressure slot of this lot carries out the pumping of the lubrication fluid toward that core, and heightens the pressure of a lubrication fluid. Since the load-carrying capacity produced as a result is in inverse proportion to a shaft and the gap between sleeves, said gap is determined that the shaft-orientations component of a force and said magnetic-attraction force of load-carrying capacity will balance, and alignment of a shaft 11 is performed by the direction component of a force of a path of load-carrying capacity. Therefore, since the magnitude of load-carrying capacity is decided by the magnetic-attraction force, it supposes that the magnetic-attraction force is set up so that sufficient load-carrying capacity to support the rotation section at the time of rotation can be generated, and a gap serves as a value of several micron meter about. Although the vertical angle of a cone configuration will think the shaft-orientations component of a force of load-carrying capacity as important in size and will think the direction component of a force of a path as important in serious consideration and smallness, the component of a force of the direction of a path is thought as important so that it can fully align in the example as a little less than 60 degrees.

[0019] A stator core 47 and a coil 50 collaborate with the rotor magnet 44, and rotate the rotation section. In addition to this, a magnetic disk or an optical disk is carried in the rotation section as a load, and the force in which it is added between a shaft 11 and a sleeve 12 according to the installation gestalt of stores, such as erection or a handstand, differs. That is, by erection, in addition to the magnetic-attraction force, moving-part weight is added, and by handstand, moving-part weight is conversely deducted from the magnetic-attraction force, and it is added. If they are taken into consideration, as magnetic-attraction force, 3 or more times of moving-part weight will be a standard, and, also experientially, the stability of an appropriate posture will be acquired. Although a precession can be compressed further and posture stability can be increased if the magnetic-attraction force is made into size and bigger load-carrying capacity is made to balance, on the other hand, it has also become clear that the sliding friction at the time of deactivation is made into size, and an operation life is reduced. Although it changes with required rotation precision, in the case of a small magnetic disk drive, it sets up as a near standard so that the about 5 times [ of moving-part weight ] magnetic-attraction force in which load weight was applied to the rotation section weight of a fluid hydrodynamic bearing motor may be generated.

[0020] Drawing 2 shows the cross section of a shaft 11, a permanent magnet 35, and sleeve 12 grade, and the path of magnetic flux. A shaft 11 is made into a non-magnetic material, and arranges the powerful permanent magnet 35 of rare earth in a shaft. The path of a permanent magnet 35 can assign about 1 - 2 millimeters on a design under the condition that the path of bearing is about 5 millimeters. Since the distance of the tip of a shaft 11 and a sleeve 12 is set as an about [ 20-30 micron m ] minute gap, the magnetic-attraction force does

not depend on the gap fluctuation, but becomes almost fixed, and processing assembly tolerance is made as for it to size. A number 55 shows the magnetization direction of a permanent magnet 35, permanent magnet 35 tip centralizes magnetic flux as the spherical surface, and the magnetic flux 56 which flowed into the sleeve 12 cone crowning returns from the cone taper side of a sleeve 12 to the other end of a permanent magnet 35 through the inside of a sleeve 12 so that it may be shown as a number 57 (number 58). Since the distance of area from a cone taper side to permanent magnet 35 edge is moreover large in size, magnetic flux 58 of flux density is dispersedly small, and is small. [ of the magnetic-attraction force of the cone taper side of a sleeve 12 and a permanent magnet 35 ]

[0021] Since magnetic fluid oil was used as a lubrication fluid, the centripetal force to magnetic fluid oil works near [ where flux density is high ] the cone crowning, and the cellular exclusion from bearing can be promoted. Trouble does not have usual oil in functional implementation of bearing, either.

[0022] Making the generating means of the magnetic-attraction force deflect the rotor magnet 44 and a stator 47 to shaft orientations otherwise, or arranging the piece of the magnetic substance under the rotor magnet 44 etc. exists. The former induces vibration and the latter has the demerit which makes the consumed electric current size by the eddy current produced in the piece of the magnetic substance. With the magnetic-attraction force generating means shown in this example, the fault of the above-mentioned means is solvable.

[0023] Drawing 3 shows the detail structure of the bearing part in the example shown in drawing 1 , drawing 3 (b) shows the top view of a sleeve 12, and drawing 3 (a) shows a shaft 11 and the cross-section structure of a sleeve 12, respectively. As shown in drawing 3 (b), the dynamic pressure slot 18 of a herringbone configuration is established in the taper section 13 of a sleeve 12 1 set. the dynamic pressure slot 18 -- several -- it is an about [ micron m ] depression, and at the time of rotation, a lubrication fluid is brought together in the core of the dynamic pressure slot 18, i.e., the crookedness part of the dynamic pressure slot 18, from an inner circumference and periphery side, the pressure of a lubrication fluid is heightened, to a sleeve 12, it rises to surface and a shaft 11 is supported. The pumping capacity from a periphery side to an inner circumference side is set up so that the pumping force by the side of inner circumference may remain as a size a little from it from an inner circumference side to a periphery side, the pressure of the lubrication fluid by the side of inner circumference is promptly made into size at the time of rotation starting, and the sliding friction of a shaft 11 and a sleeve 12 is made to mitigate in this example. Although the slot length by the side of the inner circumference section is expressed with the dynamic pressure slot 18 shown in drawing 3 (b) to size, since pumping capacity is decided by contraction extent of the hoop direction die length of a slot, the direction die length of a path of a slot, etc., it is not contradictory to the above-mentioned explanation.

[0024] The gap of the annular obstruction 23 and the peripheral wall of a sleeve 12 forms the taper seal section which carries out the seal of the lubrication fluid to shaft orientations with surface tension as a size gradually. The ring-like member 24 is fixed to the edge of the annular obstruction 23, and the inner circumference section of the ring-like member 24 is in the annular crevice 26 established in the sleeve 12 periphery wall surface, and restricts migration to the shaft orientations of the rotation section. The ring-like member 24 uses elasticity, or puts some rings on the annular crevice 26 free [ rotation ] beforehand at the time of notching and assembly, and fixes the ring-like member 24 to annular obstruction 23 edge by spot welding, adhesion, etc. through the access hole 25 prepared in the member which counters with the annular obstruction 23 after an assembly. The access hole 25 fixes [ at a hoop direction ] those with three piece, and the ring-like member 24 to homogeneity by three points in a hoop direction.

[0025] There is no taper seal section of a lubrication fluid in the cone-like bearing surface periphery section, since it has been arranged on the periphery of a sleeve 12, effectiveness is in thin shape-ization of the whole motor, and since the tooth space of the shaft orientations of the taper seal section can fully be taken, the seal structure of a lubrication fluid firm as a small include angle of 10 or less degrees is [ a taper angle ] realizable. Moreover, since there is nothing at a conical surface and the interface 17 of a lubrication fluid has been arranged between sleeve 12 peripheral walls and the annular obstructions 23 near almost perpendicularly, there is little concern from which a lubrication fluid leaks with a centrifugal force also in high-speed rotation.

[0026] Drawing 4 explains that the load-carrying capacity which appears between a shaft 11 and a sleeve 12 as a result of the pressure distribution in the lubrication fluid generated at the time of rotation and pressure distribution is shown, and the stability of a rotation posture is acquired. Drawing 4 (b) shows the pressure distributions 62, 63, 64, and 65 of the lubrication fluid generated by the dynamic pressure slot 18 at the time of rotation, and, as for an axis of abscissa 61, an axis of ordinate 60 shows the coordinate of the direction of a path for a pressure corresponding to drawing 4 (a). The apex locations 63 and 65 of the pressure are mostly equivalent to the folding point of the dynamic pressure slot 18. Since pressure distribution have deducted atmospheric pressure, they serve as zero mostly by the pressure 62 of the periphery section, but since the dynamic pressure slot 18 is set up so that the pumping force by the side of inner circumference may excel, the

pressure 64 of the location equivalent to the inner circumference section is indicated to be size from atmospheric pressure.

[0027] Drawing 4 (a) shows the load-carrying capacity produced with a shaft 11, the cross-section structure of a sleeve 12, and pressure increase of a lubrication fluid as numbers 67 and 68. Although the same load-carrying capacity as circumferencial direction each point appears, in order to simplify explanation, the Yuji Hidari point of a sectional view shows it.

[0028] Numbers 69 and 71 show the shaft-orientations component of a force of load-carrying capacity 67 and 68, and numbers 70 and 72 show the direction component of a force of a path, respectively. Since load-carrying capacity 67 and 68 is mostly in inverse proportion to the gap between a shaft 11 and a sleeve 12, a gap becomes settled so that the shaft-orientations component of a force 69 and 71 and the magnetic-attraction force between the rotation section and a fixed part may balance. It aligns a shaft 11 so that, as for the direction component of a force 70 and 72 of a path, these may balance in hard flow mutually.

[0029] Moreover, since load-carrying capacity 67 and 68 works at right angles to a conical surface, if it uses the location corresponding to the top-most vertices of a conical surface as the imagination supporting point 66 and distance of the supporting point 66 and the point that load-carrying capacity 67 and 68 acts is set to L, on a shaft 11, distance L and the moment force equivalent to the product of load-carrying capacity 67 and 68 will commit it. The moment force concerning load-carrying capacity 67 and 68 is always hard flow, since the magnitude of load-carrying capacity 67 and 68 is mostly in inverse proportion to the gap between the shaft 11 in those near, and a sleeve 12, stability works focusing on the supporting point 66 so that both gap may become equal, the posture of a shaft 11 is maintained and a precession is also controlled so that the moment force of load-carrying capacity 67 and 68 may become equal.

[0030] In the viscosity of the oil used as a lubrication fluid, generally at an elevated temperature, load-carrying capacity decreases by smallness. Although it sets up in the conventional design so that load-carrying capacity can be secured with allowances in the upper limit of operating temperature limits, it is afflicted by superfluous load-carrying capacity and the excessive current at low temperature as the result. If it depends on this invention, since the gap between a shaft 11 and a sleeve 12 becomes settled in the location where the shaft-orientations component of a force 69 and 71 and the magnetic-attraction force of load-carrying capacity 67 and 68 balance, load-carrying capacity will be kept almost constant irrespective of temperature. That is, temperature compensation is made automatically, the load-carrying capacity set point in a design is crossed to the total-temperature range, is made with a fixed value, can avoid the superfluous load-carrying capacity in low temperature, an excessive current, etc., and the low current-ized design of it is attained.

[0031] Furthermore, since **** in a fluid hydrodynamic bearing originates in the frictional force of the lubrication fluid in the interval spare time part which mainly has a dynamic pressure slot, and the field of a shaft 11 and sleeve 12 grade, if it has a dynamic pressure slot by minimum configuration called a lot like this invention, **** is small also from this point and low current-ization can be attained.

[0032] Moreover, since it is therefore decided that the moment force about posture maintenance of a shaft 11 will be the product of distance L and load-carrying capacity 67 and 68, there is no need of having 2 sets of dynamic pressure slots in shaft orientations like structure before, and making the span between them into size, and since the dynamic pressure slot 18 requires only a lot, it can also attain thin shape-ization with the simplification of structure as compared with structure conventionally.

[0033] Drawing 5 explains that the magnetic-attraction force of an axis end is still more effective in restoration of a rotation posture. The example to which drawing 5 (a) has the magnetic-attraction force in an axis end, and drawing 5 (b) show the example which makes a rotor magnet a magnetic-attraction force generating means. Since the upper part of a shaft 11 shows the example leaning to the left, as drawing 4 (a) explained, two points of right and left of the load-carrying capacity by dynamic pressure generating are represented with these drawings, and they show as numbers 67 and 68. As drawing 4 (a) explained in size from load-carrying capacity 68, the resisting moment force of a rotation posture generates the load-carrying capacity 67 used as the smallness of the gap between bearing. In drawing 5 (a), it turns out easily that the magnetic-attraction force 83 of an axis end generates the resisting moment force of load-carrying capacity 67 and 68 and a rotation posture further. the magnetic-attraction force 84 it was weak to the smallness of a gap since the magnetic-attraction force 84 and 85 between the rotor magnet 44 and the piece 53 of the magnetic substance was in inverse proportion to the gap although the magnetic-attraction force 84 and 85 on either side balanced mostly in the example of drawing 5 (b) which makes one rotor magnet 44 a magnetic-attraction force generating means -- the magnetic-attraction force 85 -- size -- becoming -- rather -- the inhibition factor of rotation posture restoration -- it becomes. Thus, the structure of having the magnetic-attraction force in an axis end contributes to stabilization of a rotation posture further.

[0034] Drawing 6 and drawing 7 show the detail structure of the drawing 1 example where it was made for a

shaft and a sleeve not to touch completely by the conical surface at the time of quiescence. In drawing 6 , in a shaft 11, it has the movable permanent magnet 35 which contacts a sleeve 12 cone crowning at the time of quiescence, and has a flat spring 33 in the crowning of a sleeve 12. Although shaft 11a shown by the dotted line shows the location at the time of quiescence and the shaft 11 of a continuous line shows the location at the time of rotation, respectively, f determines that it is always more nearly equal than d, or the amount of protrusions of a permanent magnet 35 becomes size, using the shaft-orientations flying height in the conical surface between d, a sleeve 12, and a shaft 11 as f for the gap of the permanent magnet 35 edge and flat spring 33 at the time of rotation. As the standard, the flying height f of a sleeve 12 will set it as about 5 micron m, if (f-d) has the flying height f in the range which is 10 -20-micron meter since it changes with temperature. Thus, at the time of rotation, permanent magnet 35 edge is carried out about 5 micron m, a conical surface at least carries out 10 - 20-micron meter surfacing at shaft orientations, and a rotation posture is not affected.
[0035] In cone-like bearing, it has possibility that a shaft will fit into a sleeve and friction will produce a large next door and poor starting. Although it is relative problems, such as a degree of hardness of the ingredient which constitutes the magnitude, the cone vertical angle, shaft, and sleeve of the magnetic-attraction force, and the probability to generate has small this invention in the field of the target small motor, it is completely solvable as structure shown in drawing 6 .
[0036] Drawing 7 is drawing for explaining justification of the permanent magnet 35 in drawing 6 . In the cylinder 32 within a shaft 11, a permanent magnet 35 is held movable by adult holding power rather than the magnetic-attraction force by eye a running fit. A push pressure is removed where elastic deformation of the flat spring 33 which made the permanent magnet 35 fully project beforehand on a shaft 11 at the time of assembly, and combined the sleeve 12, and applied the adult push pressure between the sleeve 12 and the shaft 11 from the magnetic-attraction force, the cone crowning of a sleeve 12 was made to contact, and the shaft 11 and the sleeve 12 touched by the conical surface, and has been arranged in the cone crowning of a sleeve 12 is carried out. After removing a push pressure, a flat spring 33 returns to the original configuration, and the shaft 11 which dotted-line 11b shows the shaft in the condition of having applied the push pressure, and is shown as a continuous line shows the condition that the gap was established in the conical surface of a shaft 11 and a sleeve 12. The same effectiveness can be acquired even if it uses the elastic deformation of the cone crowning of a sleeve 12 instead of using the elastic deformation of a flat spring 33.
[0037] After justifying, a permanent magnet 35 can also oppose excessive impulse force, if it fixes by adhesion or welding. After a cylinder's 32 holding a permanent magnet by clearance BAME or the **** stop as a through tube, making it fully project at the time of assembly and making it contact the cone crowning of a sleeve 12, it can make a considerable amount (f-d) able to project through a through tube, and can also perform justification and immobilization. If measures against wear, such as ceramic material pasting and plating processing, are furthermore taken against permanent magnet 35 point and the flat spring 33 which counters, the engine performance can be stabilized over a long period of time.
[0038] In single cone-like bearing, since it counters in the suitable location of shaft orientations even if the paths of a shaft and a sleeve differ slightly, there is the description which enables low cost-ization by making tolerance of a path dimension into size. Although a shaft 11 can also be set as the permanent magnet 35 shown in the example of drawing 6 to immobilization from the beginning, the path dimension of the amount of protrusions of a permanent magnet 35, a shaft 11, and a sleeve 12 must be managed in that case. Although a dimensional control is also easy when the engine-performance demand of NRRO as a fluid hydrodynamic bearing motor etc. is comparatively loose, when an engine-performance demand is severe, it is difficult, and the structure which justifies a permanent magnet like this example is low as total cost.
[0039] Drawing 8 (a) shows the example which has crown in the center section of the herringbone groove with axial fixed structure. The dynamic pressure slot of the herringbone configuration prepared in a conical surface is a slot with a depth of several microns shown in the conical surface of a shaft 11 in fact although it presupposed that it is flat and the dynamic pressure slots 20 and 21 on the both sides were shown that a location is intelligible in the sectional view without a center section. It constitutes so that crown 19 may be slightly formed in a shaft 11 at a conical surface and the bearing gap of a flat part strip region may serve as min, and the circumference slot 40 with a depth of about 10 microns is established in the flat part strip region with crown 19. Although the concrete dimensions of the crown section 19 differ on condition that each, they are set up so that a gap may become several micron meter grade size from the flat part strip region section by the cone inside-and-outside peripheral edge. Even if a vertical-angle setup of the conical surface of a shaft 11 and a sleeve 12 shifts slightly by considering as such structure, contact of the edge of an inside-and-outside periphery can be avoided, and there is the description to which the processing tolerance of a member is expandable.
[0040] Since a herringbone groove is the structure which made the pair two sorts of spiral grooves, pump in

and pump out, it can also be understood as having arranged the spiral groove 20 of pump out to the inner circumference side, and the above-mentioned groove structure having arranged the spiral groove 21 of pump in to the periphery side bordering on the crown section 19 from which a bearing gap becomes min. According to each role, configurations, such as the number of the grooves per round and an angle of inclination of a groove, can also be chosen the optimal, respectively.
[0041] The pressure distribution at the time of the rotation in the above-mentioned dynamic pressure slot structure etc. are shown in drawing 8 (a). A number 73 shows the coordinate of shaft orientations, a number 74 shows a pressure value, respectively, and numbers 75, 76, 77, 78, and 79 show the average pressure of a hoop direction in each shaft-orientations location. since atmospheric pressure is deducted, zero are shown, a pressure 76 increases by the dynamic pressure slot 21, and the pressure value 75 in the periphery section serves as about 1 law in the center section, as a number 77 shows. In the part equivalent to the location of the dynamic pressure slot 20, a pressure decreases, as shown in a number 78, and in the cone crowning 14, as shown in a number 79, it becomes an adult value from atmospheric pressure a little.
[0042] Although a rotation section posture is fundamentally held with the high pressure 77 in this center section, drawing 8 (b) explains to a detail further. The pressure distributions 75, 76, 77, 78, and 79 shown in drawing 8 (a) are the average values of a hoop direction, and when a shaft 11 and a sleeve 12 carry out eccentricity or it inclines, the pressure distributions of a hoop direction also differ locally. Drawing 8 (b) shows the situation which the sleeve 12 to rotate inclines to the left in the upper part, inclines to the right in a lower part, and is rotated. It is lost if the load-carrying capacity which makes it generate between middle interval **** by crown 19 has a uniform groove 20 to a hoop direction, and if it is made to represent with load-carrying capacity F11 and left-hand side as F12 and thinks on the right-hand side, F11 of a side with a small bearing gap will become size. If it is set as F21 on the right-hand side and load-carrying capacity is similarly set to F22 on the left-hand side in a groove 21, F22 of a side with a small bearing gap will become size. If the top-most vertices of a conical surface are considered to be the imagination supporting point 66 and distance to L1 and load-carrying capacity F21 and F22 is set to L2 for the distance from the supporting point 66 to load-carrying capacity F11 and F12, in L1* (F11-F12) and the sleeve lower part, the moment force of L2* (F21-F22) will be committed, and stability will work in the upper part of a sleeve so that the bearing gap in each may be made equal. Although only the moment force on either side was taken up in this explanation since it was easy, the moment force in each point of a circumferencial direction and shaft orientations will balance in fact.
[0043] Thus, by arranging the field of gap smallness in the herringbone groove middle of a lot, the rotation posture resisting moment force in which the vertical gap between a shaft 11 and a sleeve 12 is equalized, respectively can be generated, and a precession can be further controlled by the fluid hydrodynamic bearing motor of this example. Moreover, although it produces the field of the pressure size of a lubrication fluid by the wedge effectiveness when eccentricity of the band-like interval **** of crown 19 center is carried out, the delay from the part of the gap smallness by eccentricity to the part of pressure size is easy to produce unstable phenomena, such as half HOWARU, in size. The circumference slot 40 makes a hoop direction distribute the lubrication fluid of pressure size, and is effective in heightening the stability by the dynamic pressure slot relatively, and decreasing half HOWARU.
[0044] Drawing 9 (a) and (b) show the example which has a spiral-like groove in the cone-like taper side of a shaft 11. The conic shaft 11 has crown 19 with which the gap in a middle strip region serves as min, and has the spiral groove 22 of pump in on the periphery field front face. numbers 80, 81, and 82 show the average pressure in each location of shaft orientations, and as a number 82 shows by the inner circumference side from the spiral groove 22, it becomes the pressure of about 1 law. The pressure distribution which hang on the strip region which becomes the narrowest [ a gap ] from the upper part of a dynamic pressure slot, and change to a hoop direction according to the gap of a shaft 11 and a sleeve 12 as drawing 9 (b) shows appear. In this drawing, a shaft 11 inclines to the left, and the load-carrying capacity F21 and F22 in case a bearing gap serves as smallness on the right-hand side of the upper is shown. Since load-carrying capacity is in inverse proportion to a bearing gap, F22 multiplies by the distance L2 from the virtual supporting point 66 of a large next door and cone top-most vertices, the moment force of L2* (F21-F22) works on a shaft 11, and it makes a bearing gap equal. Although only the moment force on either side was taken up in this explanation since it was easy, the moment force in each point of a circumferencial direction will balance in fact.
[0045] Although uneven distribution of a pressure will appear in a hoop direction and the resisting moment of a rotation posture will be obtained if eccentricity is carried out in said example even if there is no crown section 19, there is semantics as for which the location of ununiformity distribution of the pressure is made to periphery approach by existence of the crown section 19, and moment force L2* (F21-F22) is made to size.
[0046] Drawing 10 illustrates near the bearing in the example which has a dynamic pressure slot to both sides to which bearing counters. Drawing 10 (b) shows the cross section of a shaft and a sleeve, and a permanent

magnet 35 is arranged for magnetic-attraction force generating in a shaft 11, and the spiral-like dynamic pressure slot 21 of pump in is arranged in the spiral-like dynamic pressure slot 20 of pump out at the front face of a shaft 11, and it is arranged in the upper part at the lower part. Drawing 10 (a) shows the bearing surface of a sleeve 12, and the spiral-like dynamic pressure slot 28 of pump in is arranged [ at the bearing surface of a sleeve 12 ] at an inner circumference side a spiral-like dynamic pressure slot [ of pump out ] 27, and periphery side. The depth of the dynamic pressure slots 20, 21, 27, and 28 is several micron meter, and the dynamic pressure slots 20 and 21 of shaft 11 front face and the dynamic pressure slots 27 and 28 of sleeve 12 front face are characterized by hoop direction include-angle length differing. In this drawing example, the hoop direction include-angle length of the dynamic pressure slots 27 and 28 of sleeve 12 front face is set up the more than twice of the dynamic pressure slots 20 and 21 of shaft 11 front face. The arrow head of numbers 29 and 30 shows the hand of cut of a sleeve 12.

[0047] The capacity which a dynamic pressure slot carries out the pumping of the lubrication fluid at the time of rotation, heightens a pressure, and heightens a pressure generates posture stability almost in inverse proportion to a bearing gap. Since it is distributed over a hoop direction, even if it carries out eccentricity and a bearing gap serves as smallness locally, by the time the effect is reflected as a pressure-distribution difference in a hoop direction, delay will produce a dynamic pressure slot, and the amount of delay is proportional to the include-angle length of the hoop direction of a dynamic pressure slot. As for the control system with delay, causing resonance phenomena of a certain kind is known by control from change of a controlled variable-ed, and, in the case of a fluid hydrodynamic bearing, the unstable phenomenon of a precession, an oil-whip, etc. is caused.

[0048] Therefore, it is making it distribute the above-mentioned amount of delay suitably to make this kind of unstable phenomenon mitigate, for example, the die length of the hoop direction of the dynamic pressure slot 21 is distributed, and it constitutes. However, if the include-angle length of the dynamic pressure slot which has only some to per round is distributed, the demerit of unequal and others of posture stability will also be actualized. In this invention, coexistence of the dynamic pressure slot of hoop direction include-angle length which forms in shaft 11 front face and sleeve 12 front face the dynamic pressure slot where hoop direction include-angle length differs, respectively, and is different from the homogeneity to the hoop direction of the posture stability by the heightened pressure was realized and solved. Generally processing of a dynamic pressure slot is not easy, and constituting to both sides of bearing causes a cost rise. In this example, since die forming is all possible for the cone-like shaft 11 and the cone-like sleeve 12, the fluid hydrodynamic bearing motor by which it does not become a cost rise factor and a precession cannot happen easily is realizable.

[0049] Drawing 11 shows the example of the fluid hydrodynamic bearing motor which has a free passage hole. It considers as the structure of having the free passage hole 34 to [ from the cone crowning 14 / through the gap of a permanent magnet 35 and a shaft 11 ] the cone periphery section in a shaft 11, and the cone periphery section is made to circulate through the lubrication fluid pressurized by the cone crowning 14, as shown in this drawing. The free passage hole 34 is made to fill up with the fibrous quality-of-the-material and porosity quality of the material etc., passage resistance is adjusted, while making surfacing at the time of starting prompt by making the pressure of the cone crowning 14 leave moderately, when impulsive vibration source is added, a pressurization lubrication fluid is missed and extent of damping is controlled. Furthermore, this example has the description which removes the wear powder generated into a sliding part.

[0050] Drawing 12 shows the example which can adjust the shaft-orientations location of a ring-like member, and drawing 12 (b) expands the sectional view of a bearing part, drawing 12 (a) expands the cross-section section 89 of the ring-like member circumference, and it is shown. In this example, the edge of the annular obstruction 23 shall have the through tube which joints a projected part 86 with the ring-like member 24. The ring-like member 24 is beforehand inserted in the annular crevice 26 of the sleeve 12 periphery section, is combined with a shaft 11, it dashes the inner circumference section of the ring-like member 24 against the edge 87 of said annular crevice 26 with a jig 88 while it makes the through tube of said projected part 86 and the ring-like member 24 joint through the access hole 25, is mutually inserted in said projected part 86, and is made to fix it, after the ring-like member 24 has carried out elastic deformation.

[0051] The shaft-orientations elastic deformation of the ring-like member 24 considers as about 20 micron m in said assembly process, and even when the reinforcement of the ring-like member 24 and said projected part 86 which suiting inserts in is fully applied to size, then an impact, the shaft-orientations movement magnitude of moving part including a hub 12 can be restricted to an about [ 20 micron m ] slight amount. Although the demand given to wanting to restrict the shaft-orientations movement magnitude of a magnetic disk to a slight amount is strong, a demand can be filled with examples, such as HDD, by using the elastic deformation of the ring-like member 24 like this example, without setting up each part material tolerance severely. The ring-like member 24 and said projected part 86 can be assembled, can raise bonding strength with means, such as

adhesion and welding, further behind, and can also raise shock resistance.
[0052] Drawing 13 makes conductive magnetic-substance fines mix into a lubrication fluid, and in order to explain the example which makes it restrain in the field of an axis end and a sleeve, and realizes the flow between the rotation section and a fixed part easily, it shows a shaft 11 edge and about 12 sleeve detail cross section. When heights 36 are formed in the center of a sleeve 12 cone crowning and the conductive magnetic-substance fines 37 are made to mix into a lubrication fluid, the conductive magnetic-substance fines 37 are concentrated between the central heights 36 of a sleeve 12 and the magnets 35 which magnetic flux concentrates, a bridge is constructed in between both, and it is made to flow. The conductive magnetic-substance fines 37 cover and form gold in extent in which magnetism is not lost for example, in a magnetic ferrite ingredient by the thickness of about 100A as small 0.2 or small diameter extent of 0.3-micron meter.
[0053] In the example of this invention, it considered as the structure which eliminates the joint between members at the part which a lubrication fluid contacts. Although the seal of the member joint was carried out by caulking, adhesion, or laser ** arrival in the conventional structure, at the time of mass production, junction was often poor, the leakage of a lubrication fluid was produced and the fatal failure was caused. The fluid hydrodynamic bearing by this invention can eliminate the joint which touches a lubrication fluid, as shown in an example, and it can realize a fluid hydrodynamic bearing motor without oil leakage concern.
[0054] As an ingredient of a shaft and a sleeve homaxial receiving part, stainless steel and the metallic material used for the fluid hydrodynamic bearing from the former like a copper alloy can be used. It is effective in reducing the wear at the time of deactivation to form thin films, such as nickel, titanium, DLC, and second-class-ized molybdenum, in one front face of a cone taper side, and it is desirable.
[0055] If reference is made about the manufacture approach of a bearing part, as the shaft of a convex configuration of the bearing member in connection with this invention being natural as an example shows, mold omission will be easy also for the sleeve which is a concave surface in the configuration extended upwards, and the inclination can carry out coincidence shaping of it also including a dynamic pressure slot using techniques, such as a press or injection molding. Therefore, die forming by the ceramics, a sintered alloy, etc., die forming using the resin ingredient which was excellent in abrasion resistance like PPS (polyphenylene sulfide resin) containing a carbon fiber, etc. are possible, and it is suitable for manufacture by low cost.
[0056] In the example of this invention shown in drawing 1 , although the example which shows a shaft 11 and a hub 41 to drawing 8 , drawing 9 , drawing 10 , and drawing 11 showed the sleeve 12 and the hub 41 as integral construction, a hub 41, a shaft 11, or sleeve 12 part can be made according to an individual, and assembly immobilization can also be carried out. It combines with each property specification to demand, and the low approach of cost is chosen. However, in the example of HDD shown in the example, the specification about the height and inclination of a loading side of a magnetic disk is severe, and if it takes into consideration that they are greatly influenced by relative physical relationship with the bearing surface, forming a shaft 11 or a sleeve 12, and a hub 41 as one will tend to realize precision. The fluid hydrodynamic bearing motor of this invention also makes a sleeve and hub unification structure possible, and can realize a highly precise motor by low cost.
[0057]
[Effect of the Invention] As mentioned above, if it depends on the fluid hydrodynamic bearing motor of this invention as explained using the example Bearing has a dynamic pressure slot in a cone configuration taper side. The load-carrying capacity and the magnetic-attraction force by the heightened pressure Also with stabilization of the rotation posture which is the simple structure to equilibrate and is a technical problem, and high rotational speed, realize seal structure of a stable lubrication fluid etc. and temperature compensation of the load-carrying capacity of the formation of mass-production low cost by die forming, thin-shape-izing of a fluid hydrodynamic bearing motor, and rotation section support and low current-ization are also realized to coincidence. The purpose of this invention can fully be attained. It can use for rotation mold storage, such as a small magnetic disk drive and an optical disk unit, the cooling fan of CPU, etc. especially.

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[Translation done.]

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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## DRAWINGS

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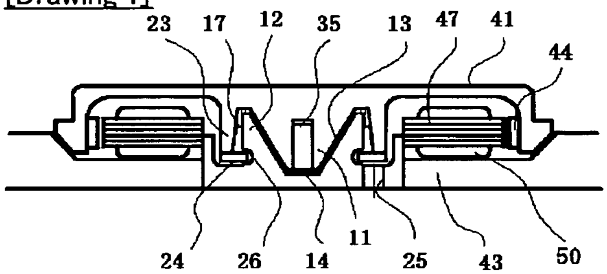
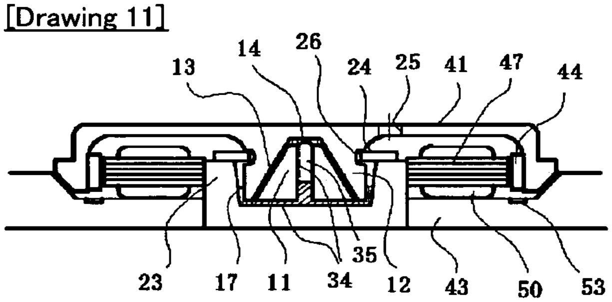
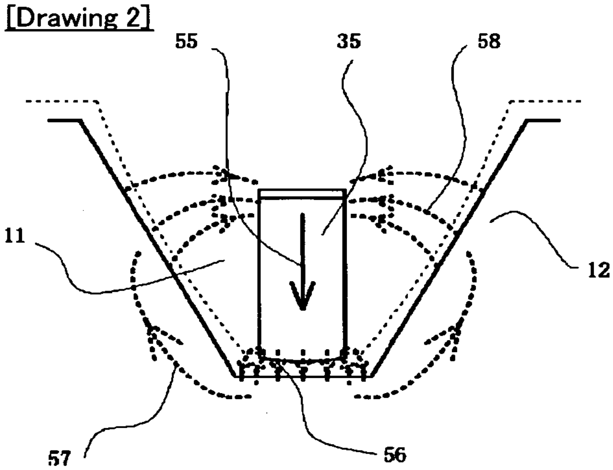
[Drawing 1]



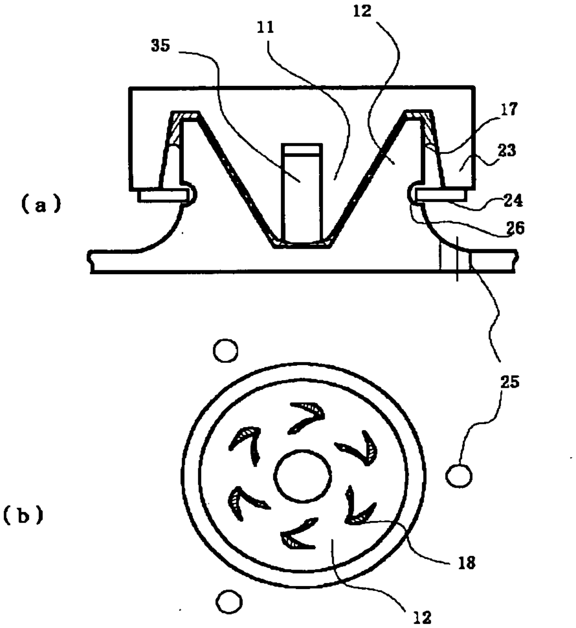

[Drawing 11]




[Drawing 2]




[Drawing 3]

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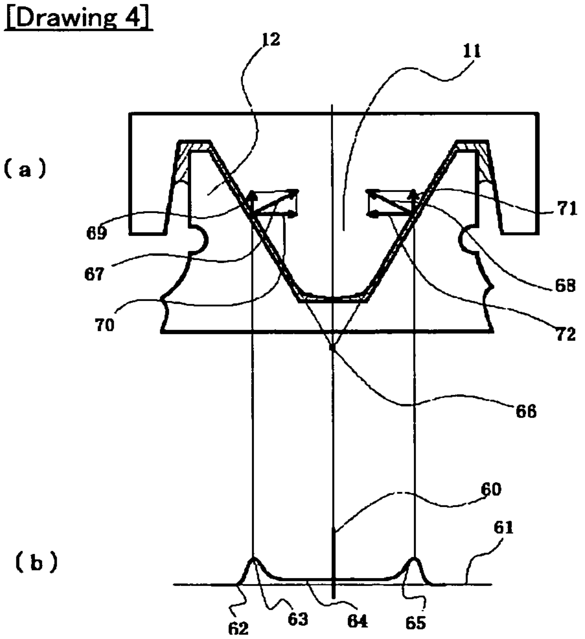


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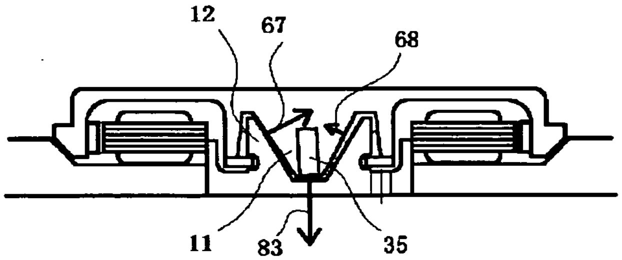
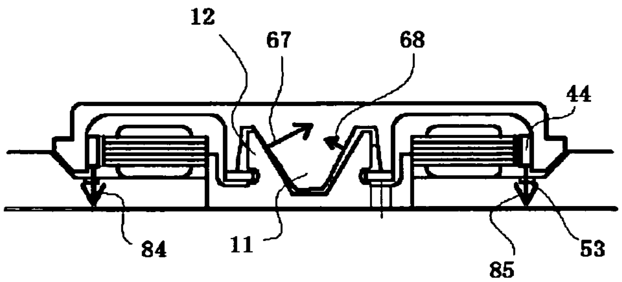
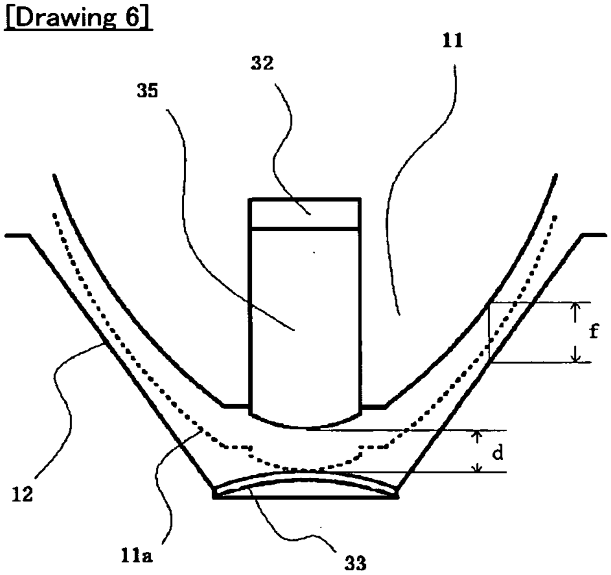



( a )

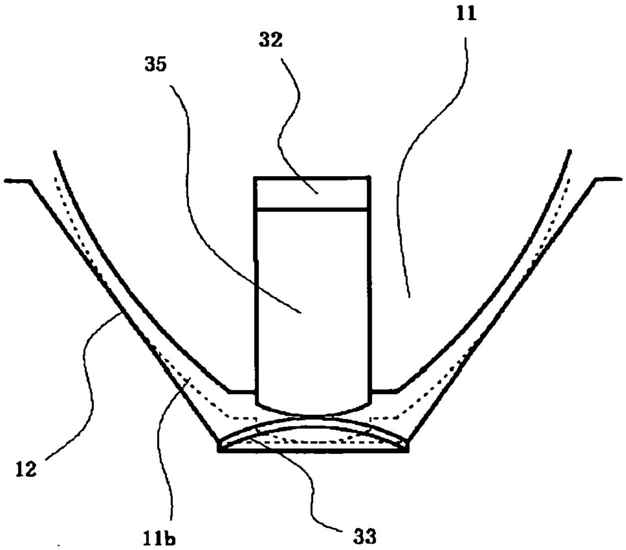



( b )

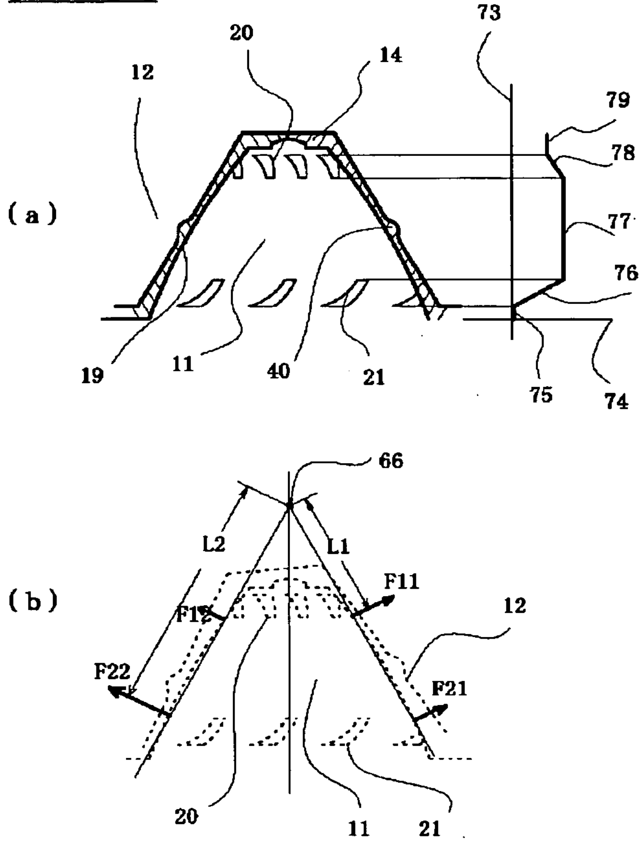
[Drawing 6]



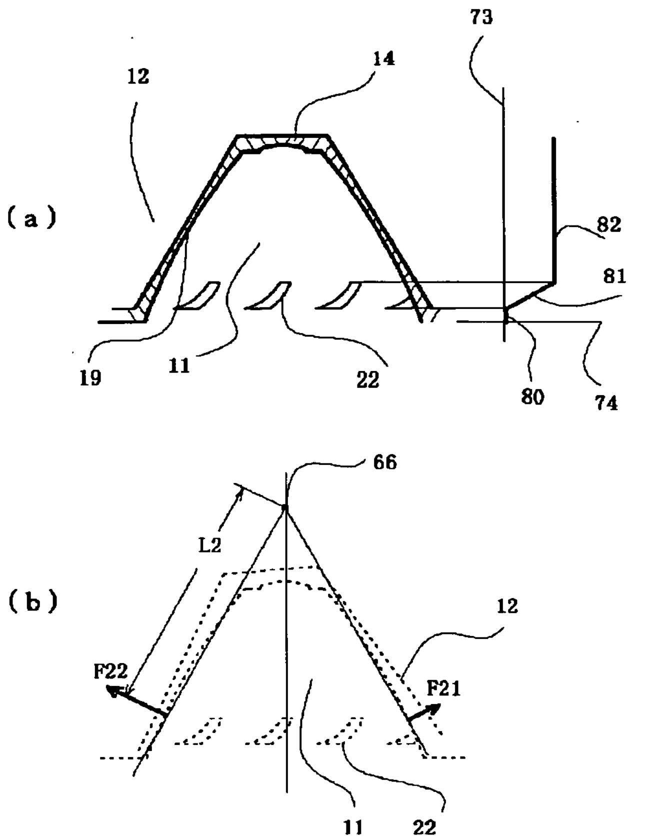

[Drawing 7]



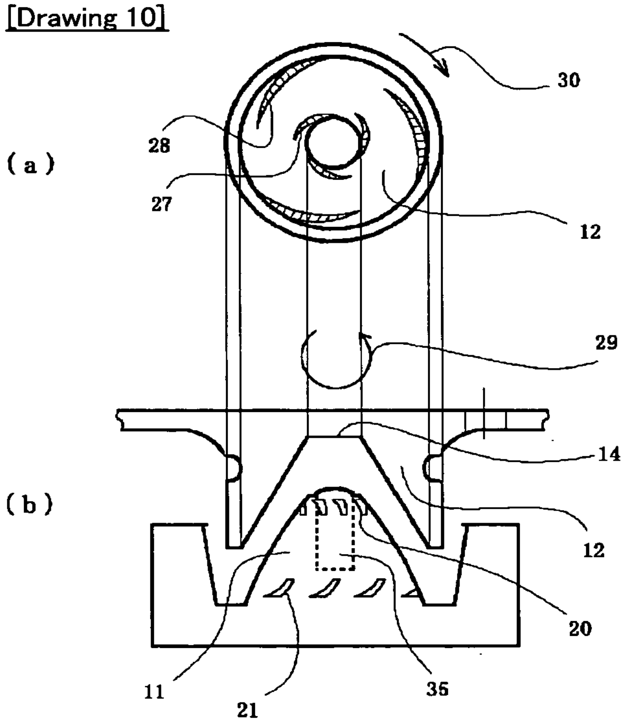

[Drawing 8]




[Drawing 9]

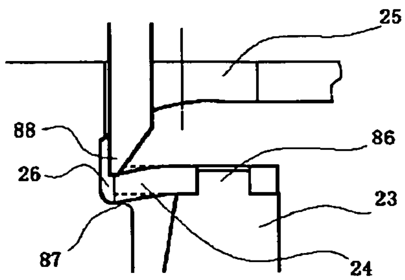



[Drawing 10]




[Drawing 12]

(a)

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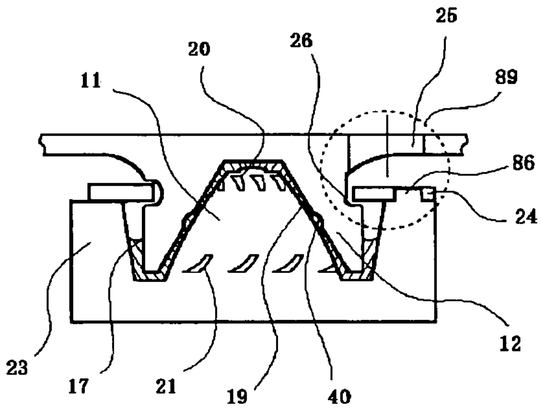
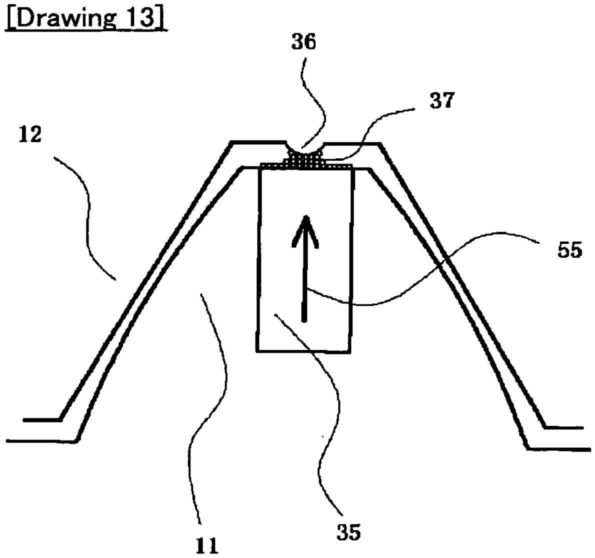
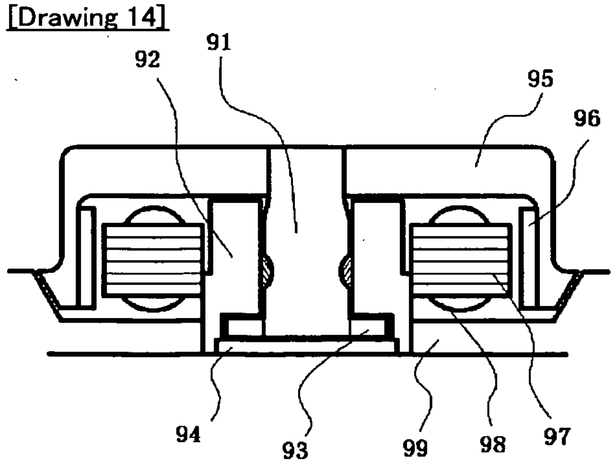



[Drawing 13]




[Drawing 14]



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